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US 5458367 A US 5366241 A US 4536008 A

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(54) Abstract Title
Roof mounted air-bag

(57) An air-bag (8) is mounted in the roof of a motor vehicle to be deployed in front of an occupant (7) of the vehicle. The air-bag is constrained by means of tear-straps (15) within the air-bag to inflate initially as a "curtain" in front of the occupant of the vehicle, that occupant only having a relatively narrow thickness (T). When the tear-straps break, the bag has a more rounded configuration. The bag is releasably retained within a recess (9) which initially houses the bag. When the bag is fully inflated, the bag becomes totally separated from the recess, to prevent the bag forcing the head of the occupant rearwardly as the torso of the occupant moves forwardly during an accident.

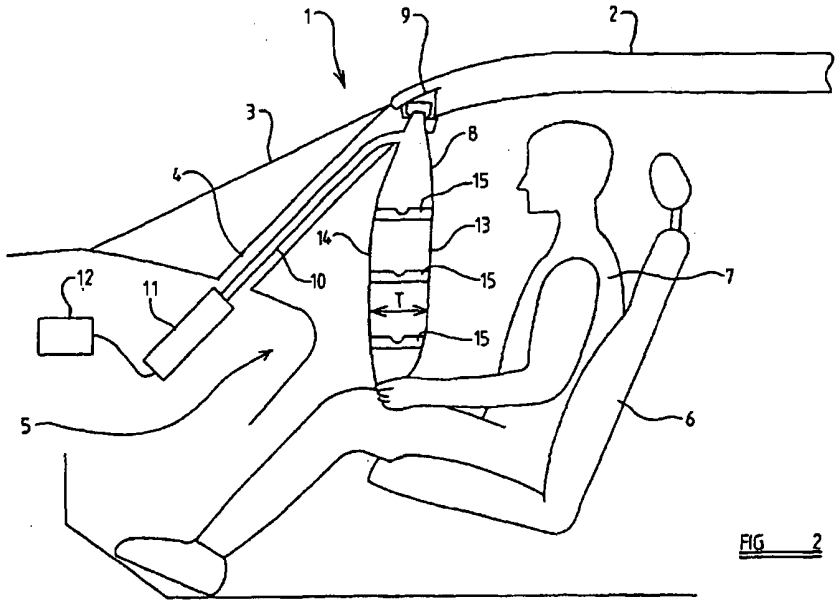

FIG 2

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

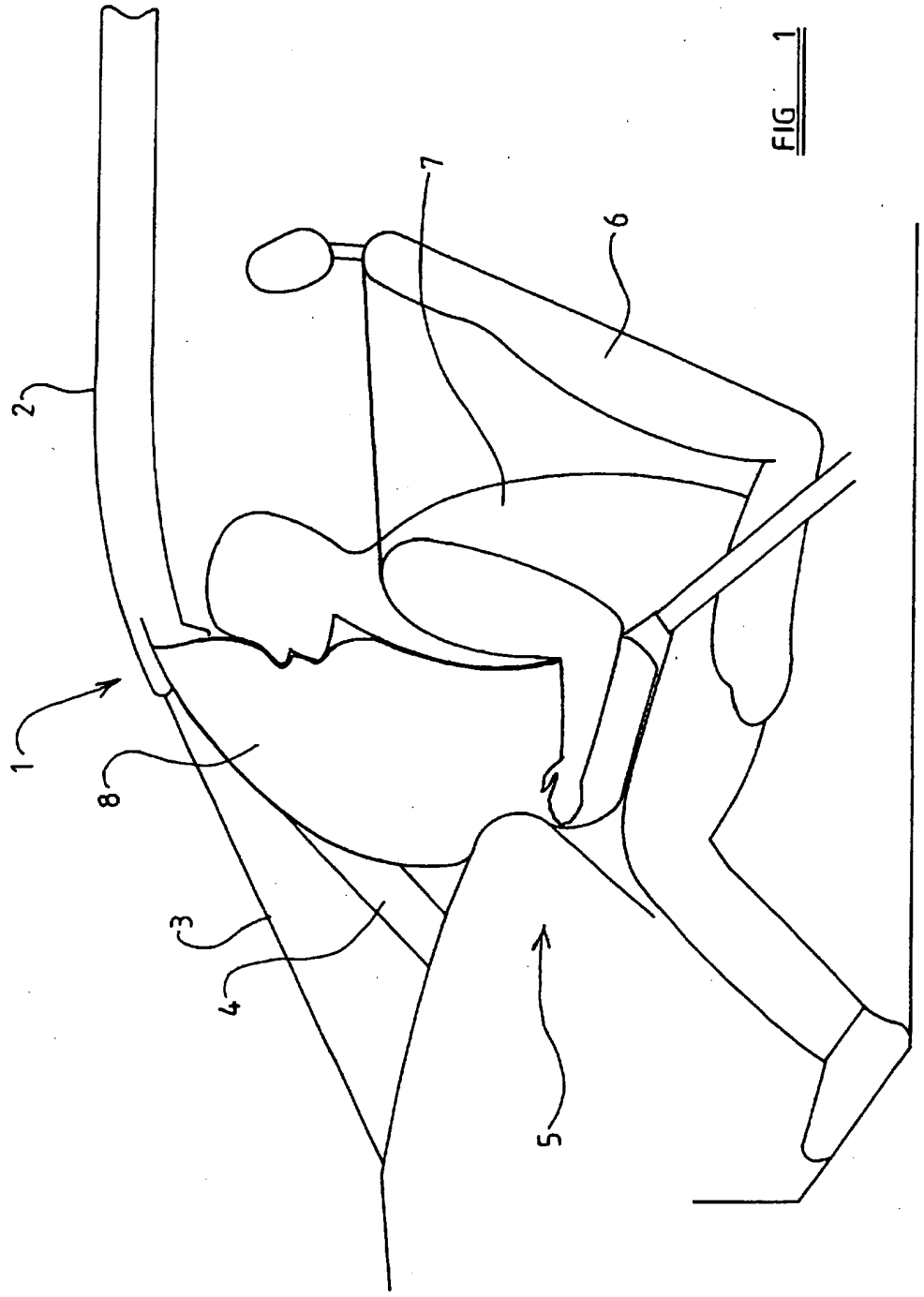


FIG 1

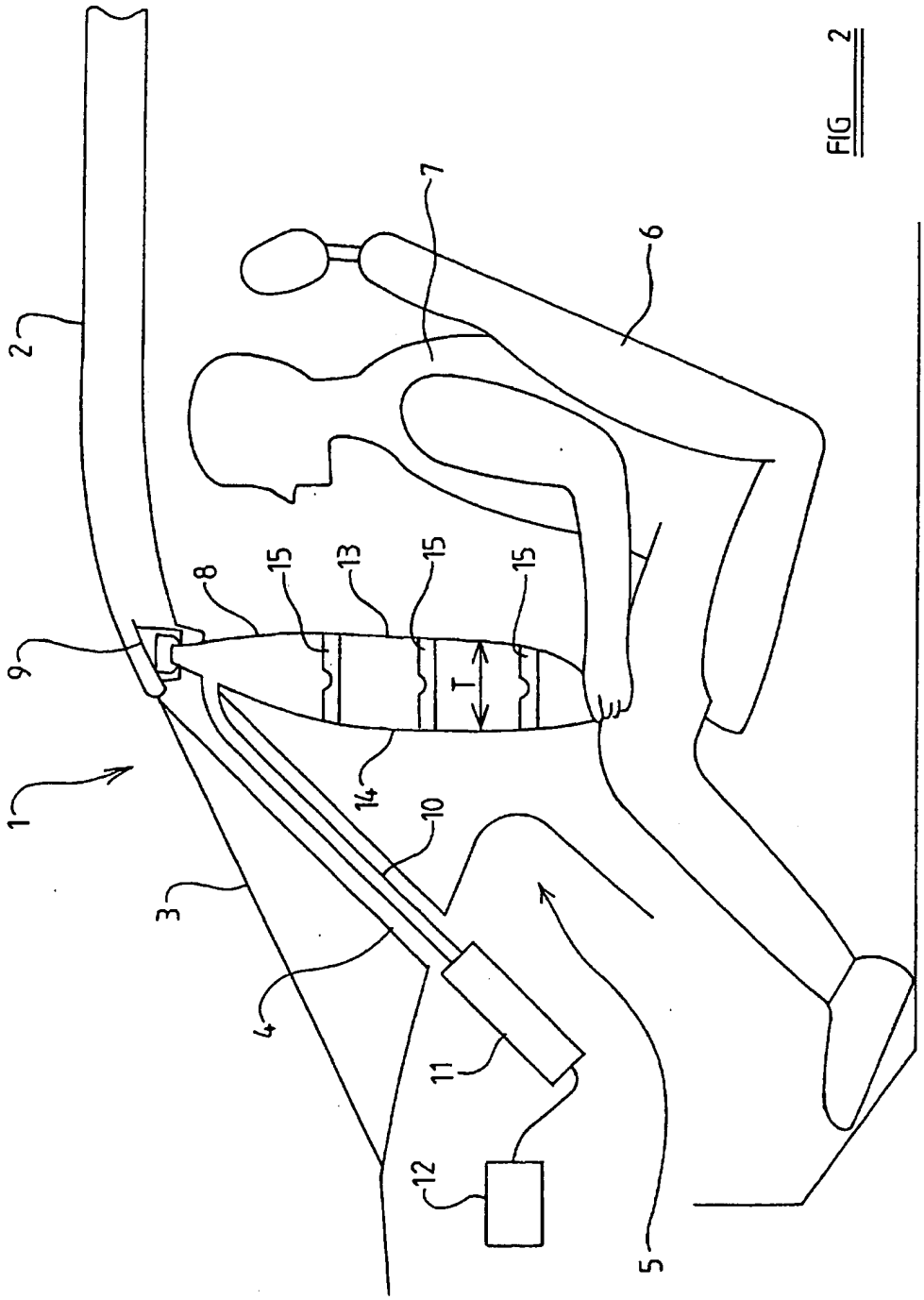


FIG 2

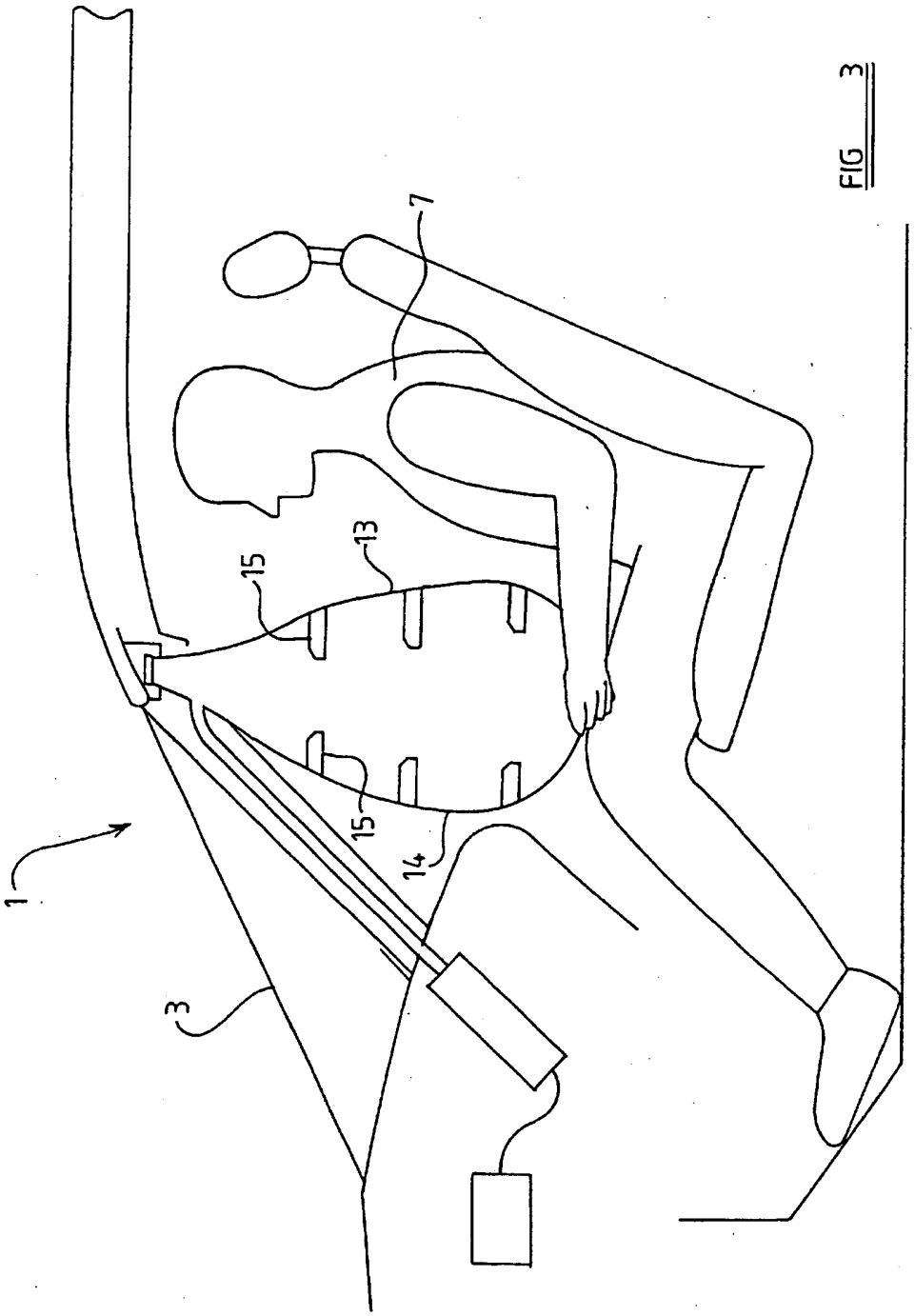


FIG 3

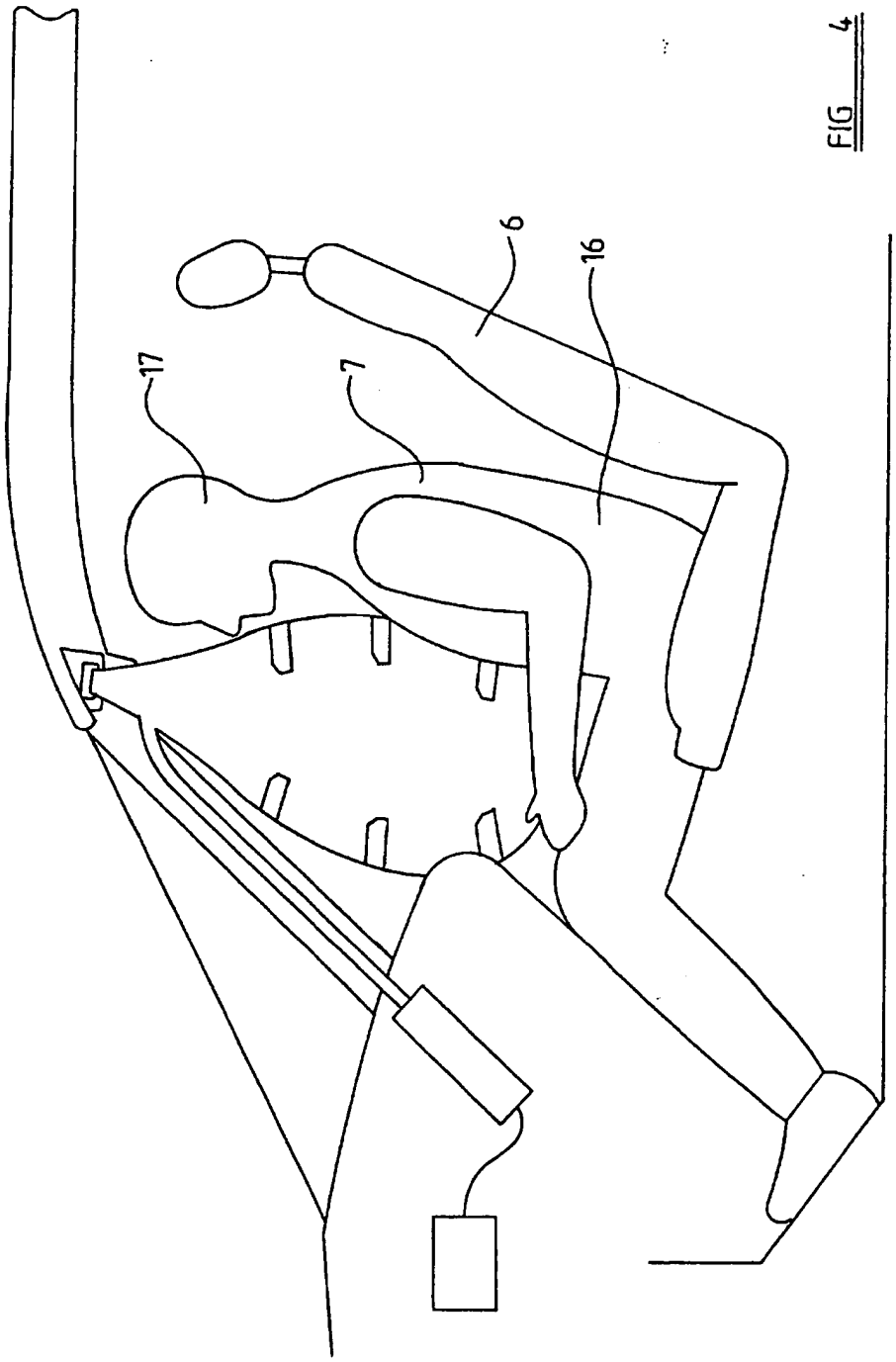


FIG 4

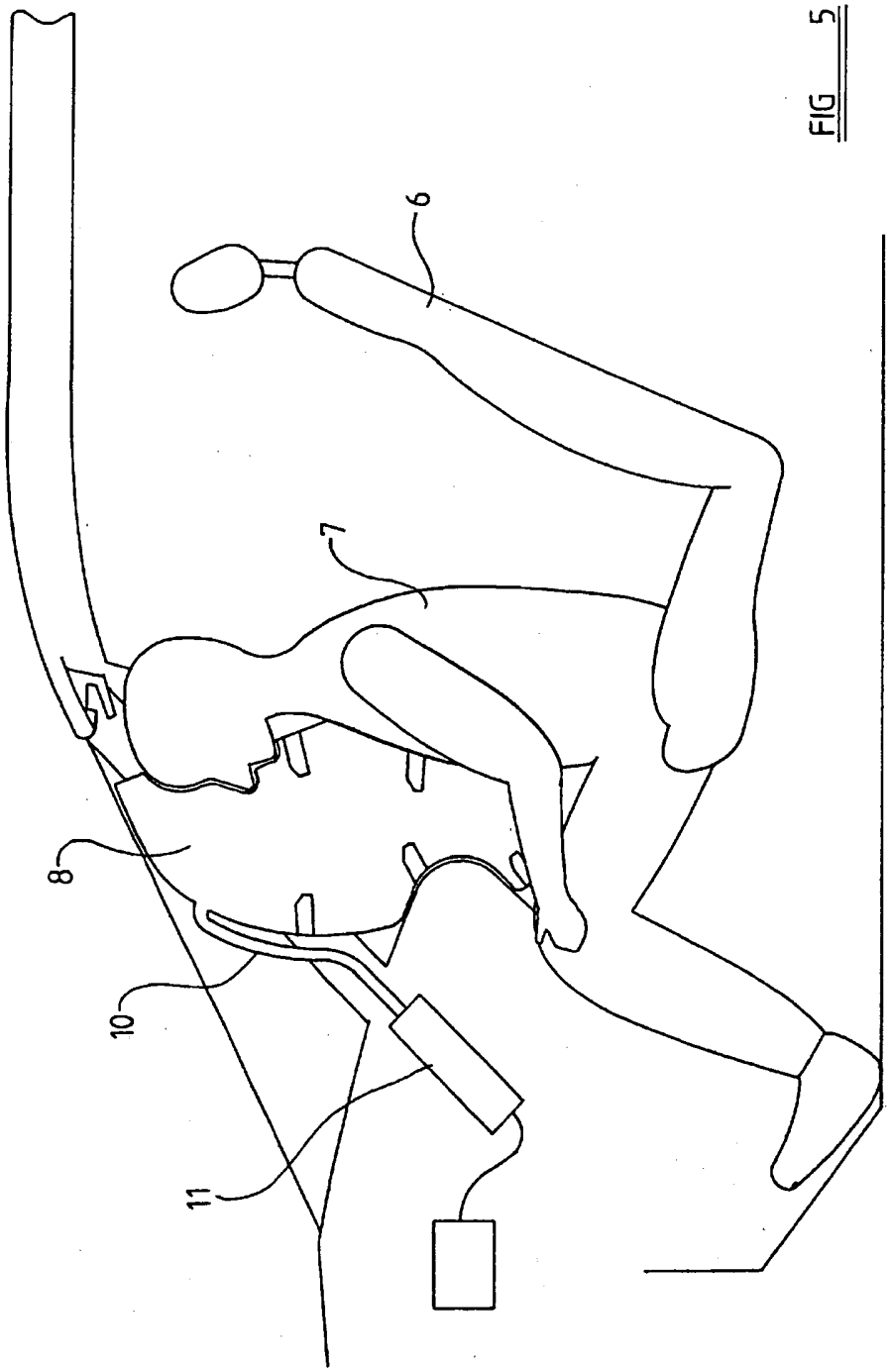


FIG 5

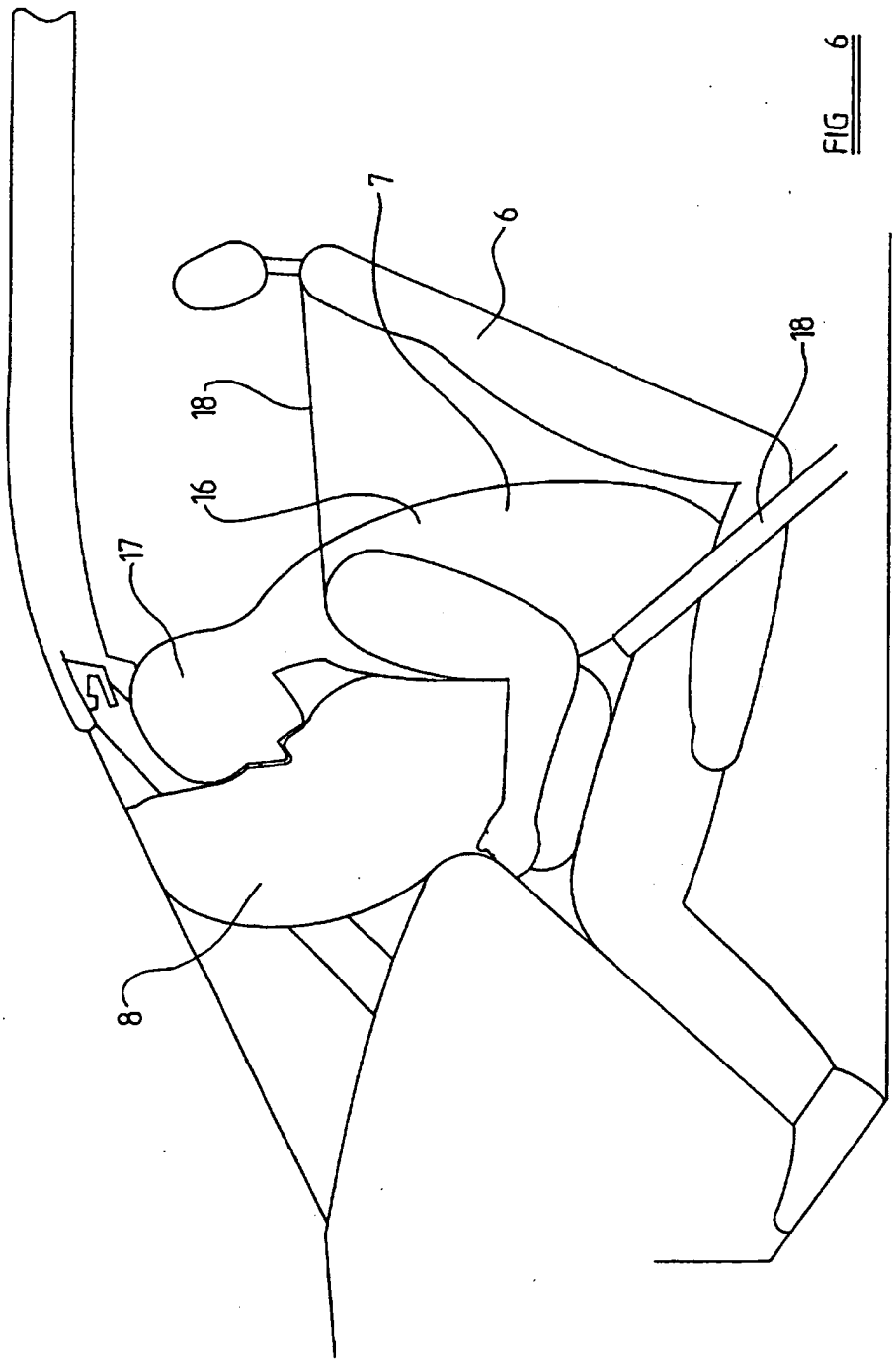


FIG 6

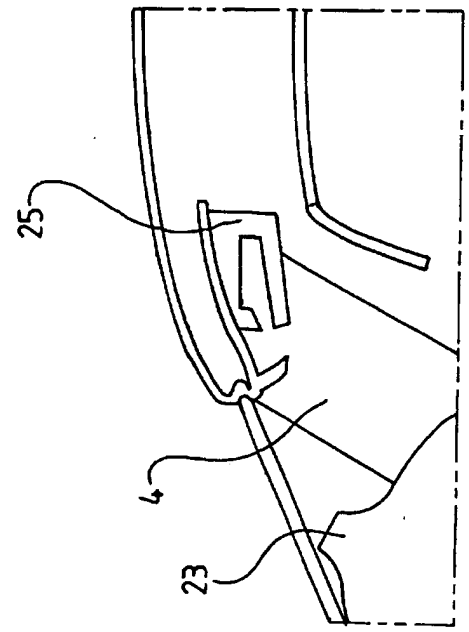


FIG 8

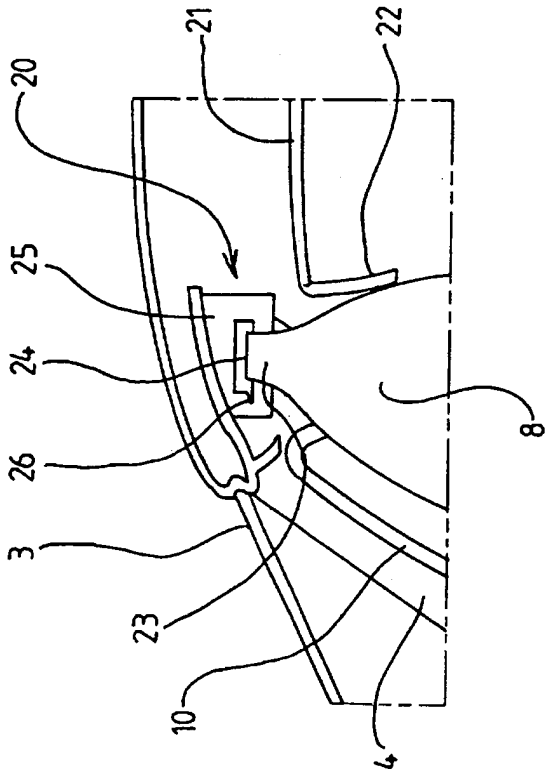


FIG 7

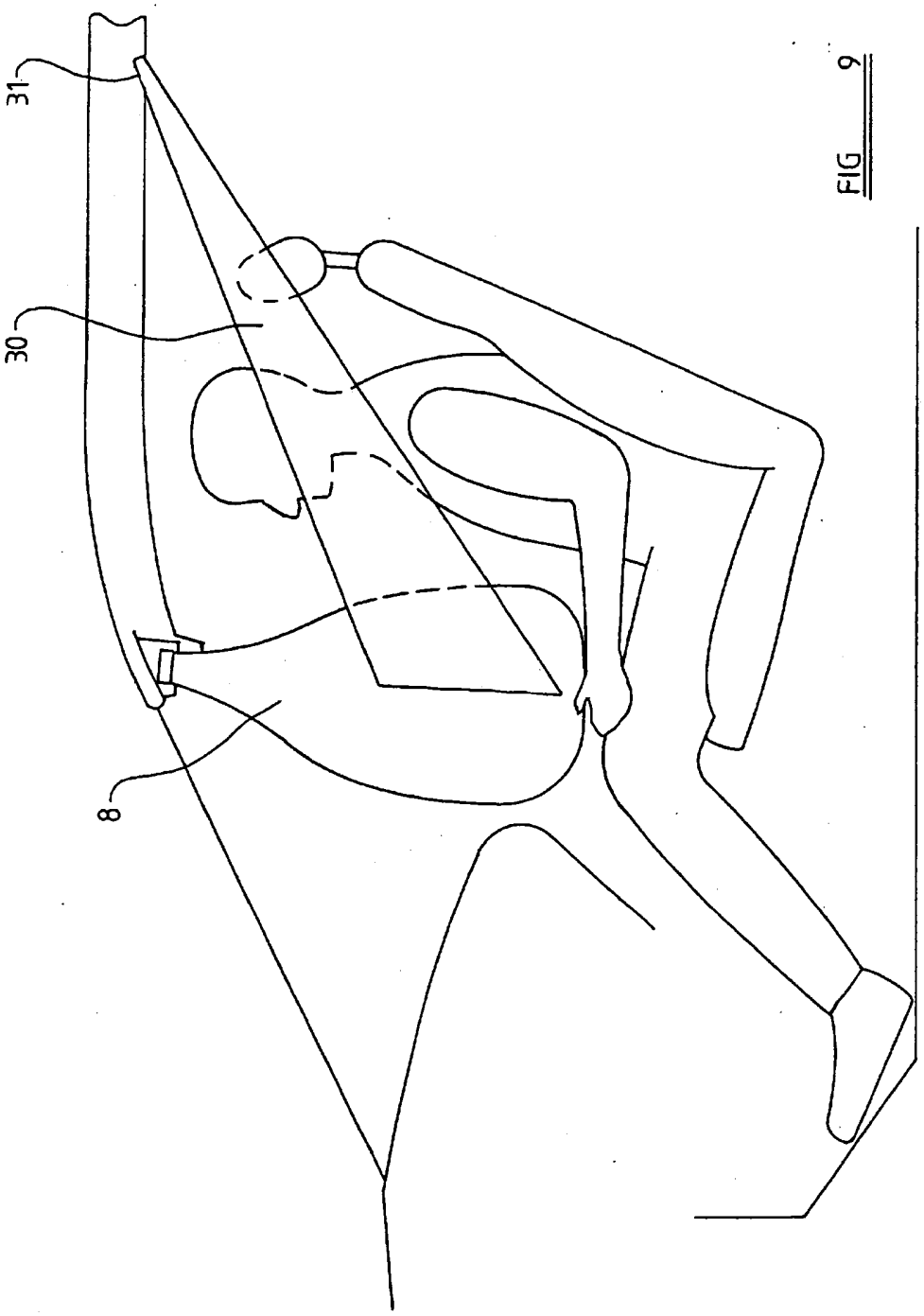


FIG 9

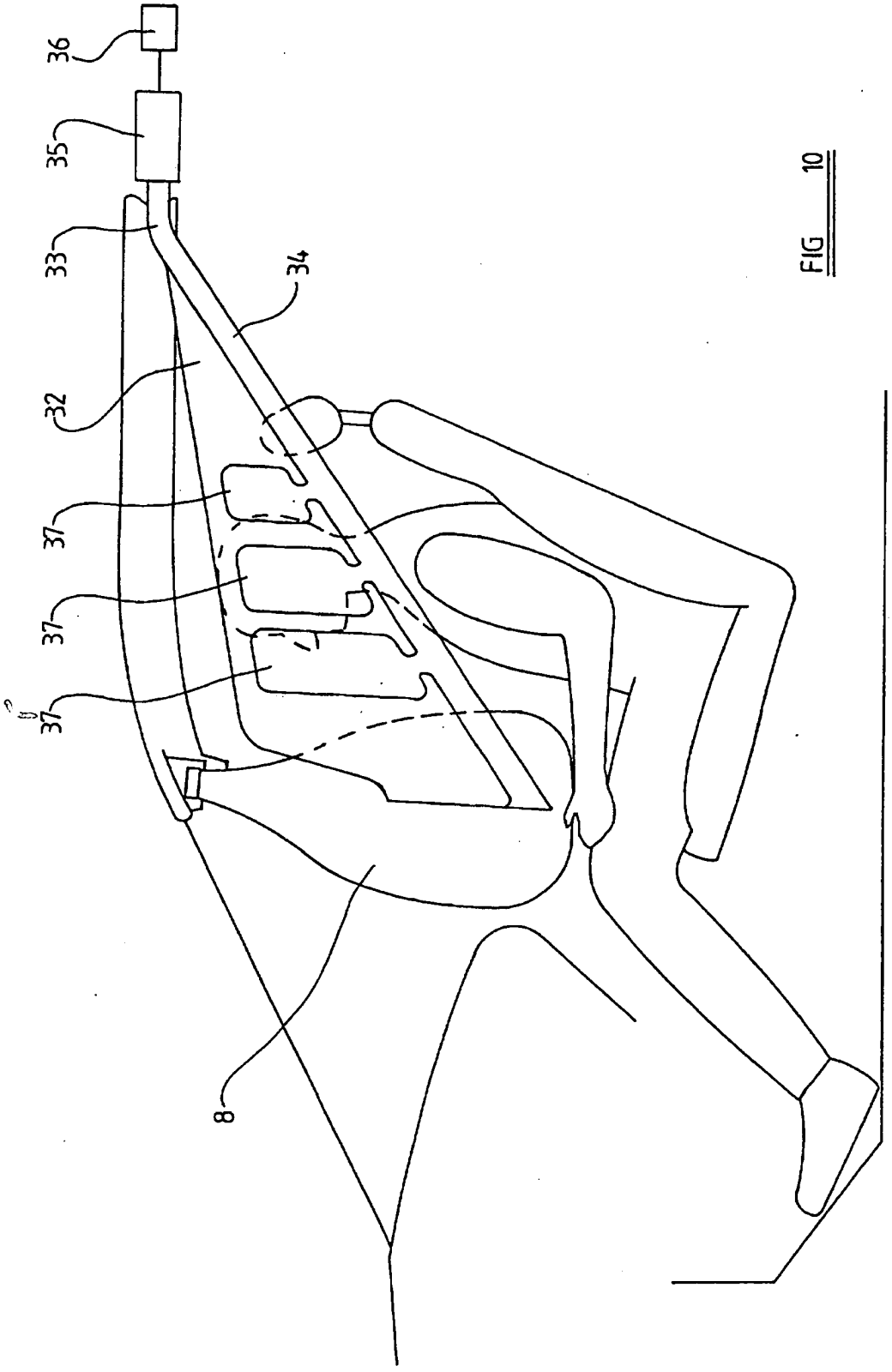


FIG 10

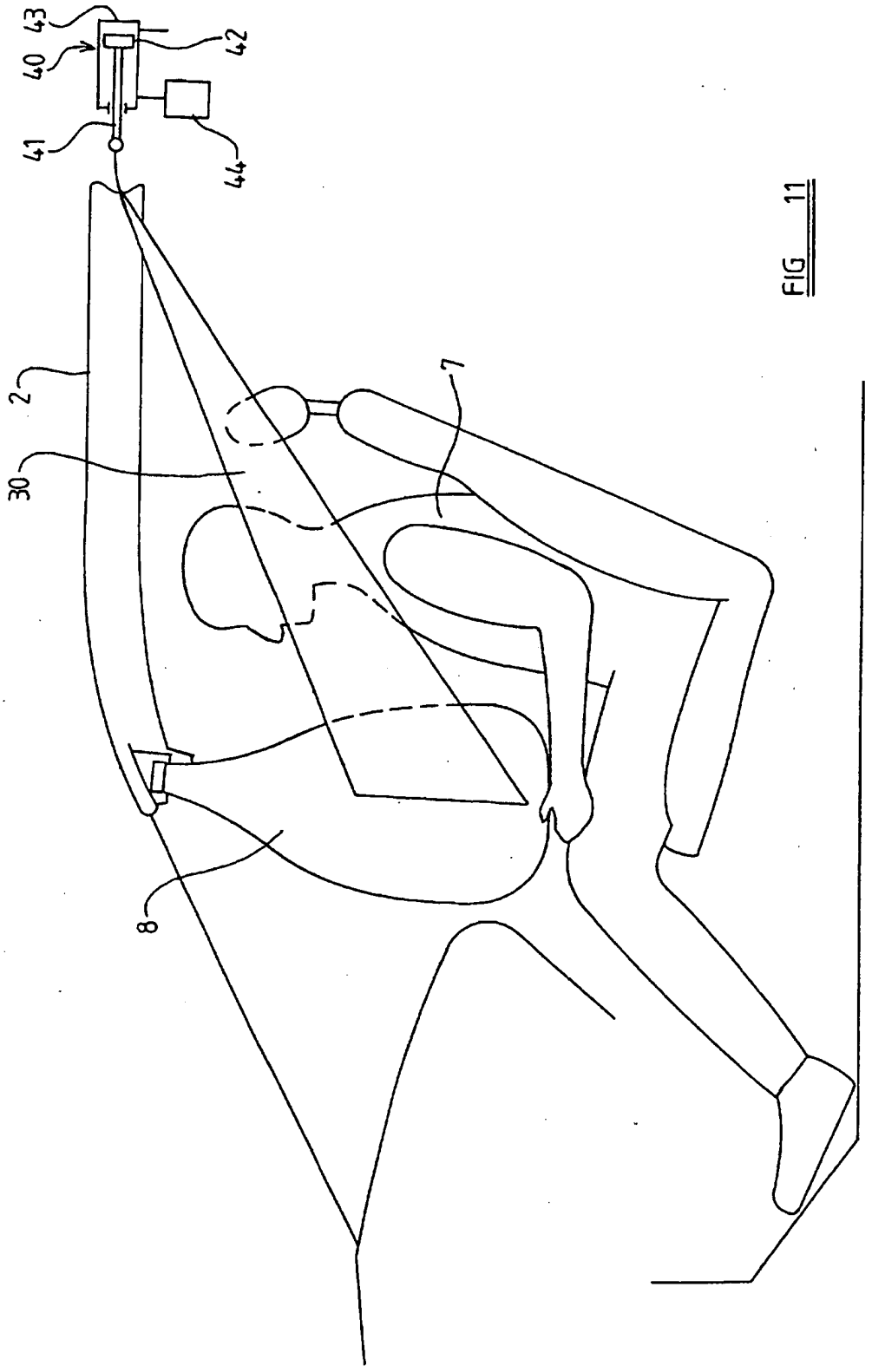


FIG 11

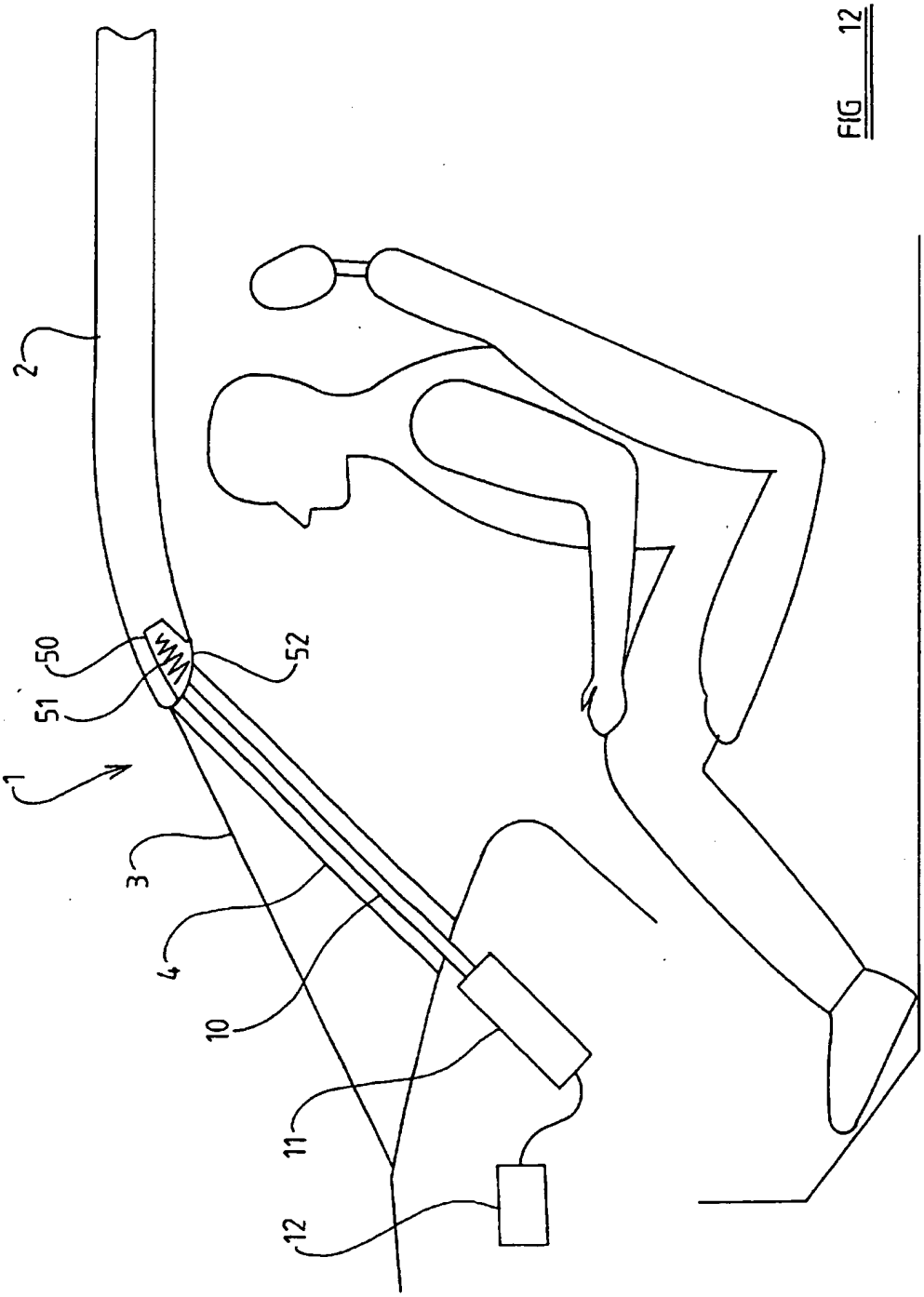
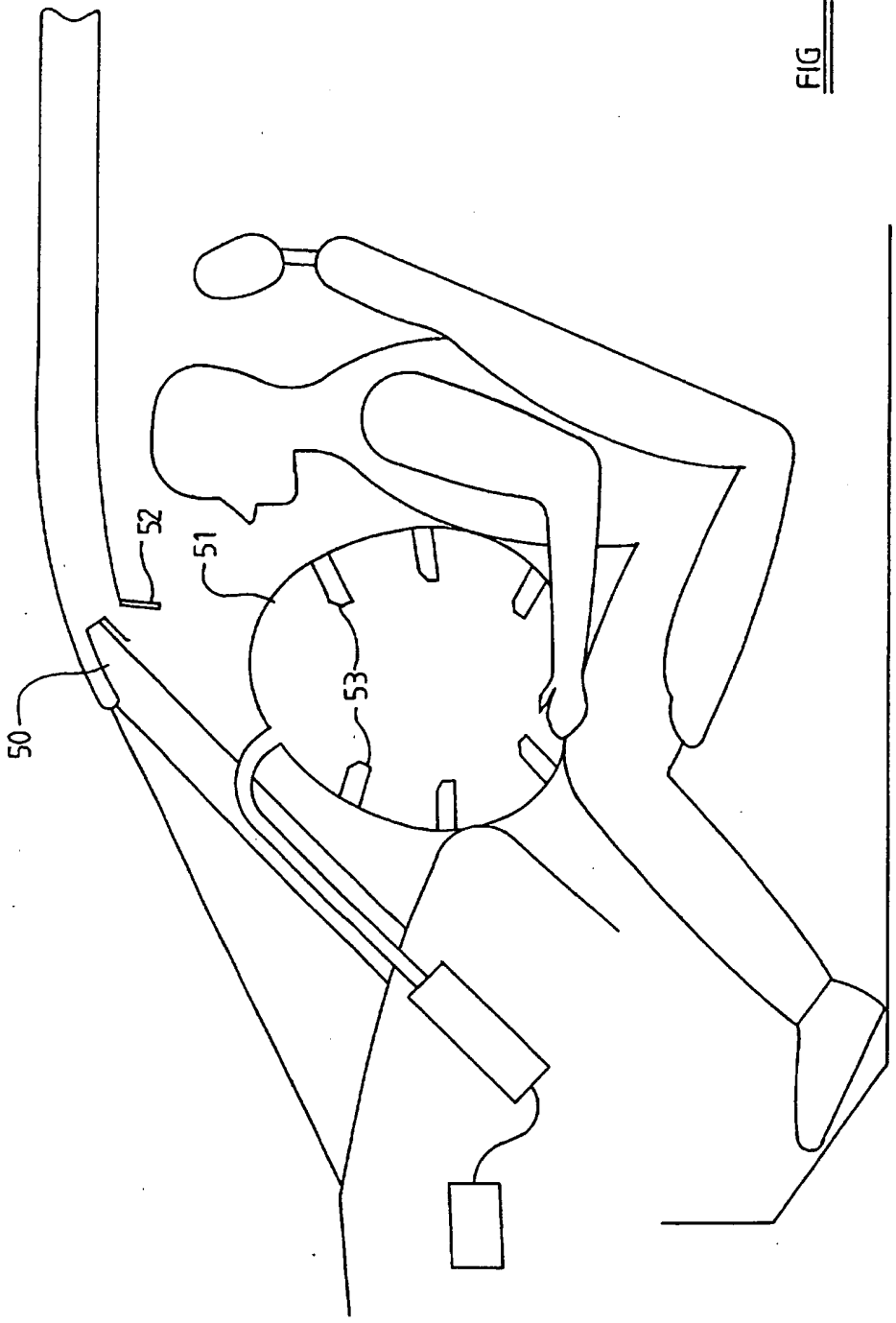


FIG 12

FIG 13



PATENTS ACT 1977

P12967GB-NF/jsd

DESCRIPTION OF INVENTION

THE PRESENT INVENTION relates to an air-bag arrangement, and in particular relates to an air-bag arrangement for use in a motor vehicle, such as a motor car, to provide protection for the driver or an occupant of the vehicle in the event that an accident should arise.

It has been proposed previously to provide an air-bag arrangement in a motor vehicle in which an air-bag is mounted in the roof of the vehicle and is adapted, when deployed , to occupy a position in which at least part of the air-bag is located in front of the occupant of the vehicle to be protected.

US A 3795412 discloses an air-bag arrangement in which a plurality of inflatable tubes are provided which are initially stored in the roof of a vehicle, above the driver. The tubes are associated with netting that interconnects the tubes. In the event that an accident arises the tubes are inflated and extend downwardly from the roof of the car forming a cage that surrounds the occupant of the car and also the back of the seat in which the occupant of the vehicle is sitting. Thus the head and torso of the occupant are prevented from moving forwardly or laterally relative to the back of the seat. It is thought that if this system were to be used, in an accident situation the head of the occupant, which typically moves forwardly relative to the torso - since the torso is usually restrained by a seat belt - will engage the combination of the inflatable tubes and the netting and will be bent rearwardly relative to the torso, which may lead

to undesirable injuries. At the conclusion of the accident, the occupant will still be encaged by the netting, even if the inflatable tubes deflate, and thus may have great problems in leaving the vehicle. This is undesirable since in many cases it is desirable for the occupants of a vehicle to leave the vehicle as soon as possible after an accident has occurred. A further problem with this arrangement is that if the occupant of the vehicle is leaning forwardly at the instant that the air-bag arrangement is deployed, they may be held in the forward position, instead of in the upright position, which may lead to an increase in the injuries sustained, rather than a decrease.

US A 3774936 discloses an arrangement in which an air-bag is mounted in the roof of a vehicle in a housing that extends transversely of the rear seat. The air-bag, when deployed, is located in front of an occupant of the vehicle seat. The air-bag is associated with wires on each side of the vehicle. Each wire is an endless loop which is connected to anchoring points in the roof and behind the shoulder of the occupant of the seat, there being a loop of fabric on the air-bag that surrounds the wire of the endless wire loop. The arrangement guides the inflating air-bag so that, when inflated, the air-bag applies a downward and rearward force on the pelvic area of the occupant of the seat, as well as providing a physical barrier in front of the seat occupant to restrain forward movement. In use of an arrangement of this type there is again a risk that the head of the occupant will engage the inflated bag before the torso, and thus the head will be bent back in an undesirable manner relative to the torso.

US A 4536008 also discloses an air-bag arrangement in which an air-bag is mounted on the roof of a motor vehicle to be deployed to occupy a position in front of an occupant of the vehicle in the event that an accident occurs. The air-bag is designed so that the lower end of the air-bag engages and applies a downward force to the lap of the occupant of the vehicle to retain the occupant

of the vehicle in the desired position, whilst also forming a barrier in front of the occupant. The upper part of the air-bag is mounted to the roof of the vehicle in such a way that the upper part of the air-bag can move forwardly, from its initial position, by up to a predetermined distance if the occupant of the vehicle applies a substantial force to the inflated air-bag. The upper part of the air-bag moves against a bias provided by springs. Again it is thought that if the head of the occupant makes contact with the air-bag after is has been deployed, even though the top part of the air-bag can move forwardly slightly, nevertheless, there is still a severe risk that the neck of the occupant will be bent back as the torso continues to move forwardly while the head is restrained.

The present invention seeks to provide an improved air-bag arrangement.

According to one aspect of this invention there is provided an air-bag arrangement in a motor vehicle to protect an occupant of the vehicle in the event that an accident should occur, said arrangement incorporating an air-bag, the air-bag initially being retained in a folded condition within a recess at a position above and in front of the occupant to be protected, the air-bag being associated with a gas generator and a sensor, the sensor being adapted to sense an accident and activate the gas generator to inflate the air-bag, the air-bag, on inflation, being deployed in front of the occupant of the vehicle, the means retaining the air-bag in the recess being adapted to release the air-bag.

In one embodiment the air-bag is retained in position within the recess by means adapted to release the air-bag from the recess when a force in excess of a predetermined force is applied to the air-bag.

Preferably the upper part of the air-bag is secured to frangible means adapted to break to release the air-bag.

Conveniently to retain the air-bag within the recess, the upper part of the air-bag is provided with a plurality of loops, each loop passing through an aperture formed in a release block, the release block being adapted to break to release the loop and thus to release the upper part of the air-bag.

Advantageously the release block is provided with a line of mechanical weakness adjacent said aperture, the release block breaking at the line of mechanical weakness to release the loop.

In an alternative embodiment the air-bag is initially retained in a folded condition within the recess by a door which initially closes the recess, the door being adapted to be opened on inflation of the air-bag, to release the air-bag during inflation thereof.

Conveniently the air-bag is provided with at least one strap extending from one lateral side of the bag to an anchor point located above and behind the occupant.

Preferably two said straps are provided, each extending from a respective lateral side of the air-bag.

Advantageously the or each strap is of substantially triangular form, the end of the strap secured to the air-bag being wider than the end of the strap connected to the anchor point.

Conveniently at least one strap incorporates at least one inflatable cell.

Preferably both straps are provided with at least one inflatable cell.

Conveniently the or each cell in the or each strap has a cylindrical form when inflated, the axis of the cell intersecting the line of the lower edge of the strap.

Advantageously there are a plurality of cells in the or each strap.

Preferably the or each strap incorporates a gas duct to supply gas to the or each cell, the gas duct supplying gas from the gas generator to the air-bag.

Conveniently the or each strap is connected to the anchor point by means of an arrangement which is adapted to apply a tension to the strap to draw the inflated air-bag towards the occupant of the vehicle.

Advantageously the strap is connected to the anchor point by means which are adapted to provide a force limiting effect when subjected to a force via a strap.

Preferably the strap is connected to the anchor point by a piston which is movable within a cylinder, gas generator means being provided adapted to inject gas into the cylinder to move the piston.

In a preferred embodiment the air-bag is provided with one or more breakable means extending from the part of the air-bag closest to the occupant to the part of the air-bag furthest from the occupant, said breakable means being dimensioned to maintain the air-bag in a relatively thin condition (as

measured in the direction of the axis of the vehicle) until a predetermined pressure is present within the air-bag.

Conveniently the air-bag is provided with one or more breakable means extending from the part of the air-bag closest to the occupant to the part of the air-bag furthest from the occupant, said breakable means being dimensioned to maintain the air-bag in a relatively thin condition (as measured in the direction of the axis of the vehicle) until a predetermined pressure is present within the air-bag.

This invention also relates to air-bag arrangement in a motor vehicle to protect an occupant of the vehicle in the event that an accident should occur, said arrangement incorporating an air-bag, the air-bag initially being stored in a folded condition at a position above and in front of the occupant to be protected, the air-bag being associated with a gas generator and a sensor, the sensor being adapted to sense an accident and activate the gas generator to inflate the air-bag, the air-bag, on inflation, being deployed in front of the occupant of the vehicle wherein the air-bag is constrained to be inflated in such a way that during the initial stages of inflation the air-bag is relatively thin (as measured in the direction of the axis of the vehicle) and is located in front of the occupant, and subsequently the thickness of the air-bag (as measured in the direction of the axis of the vehicle) increases.

This invention additionally relates to air-bag arrangement in a motor vehicle to protect an occupant of the vehicle in the event that an accident should occur, said arrangement incorporating an air-bag, the air-bag initially being stored in a folded condition at a position above and in front of the occupant to be protected, the air-bag being associated with a gas generator and a sensor, the sensor being adapted to sense an accident and activate the gas

generator to inflate the air-bag, the air-bag, on inflation, being deployed in front of the occupant of the vehicle, wherein the air-bag is provided with at least one strap extending from one lateral side of the bag to an anchor point located above and behind the occupant.

In order that the invention may be more readily understood, and so that further features thereof may be appreciated, the invention will now be described by way of example with reference to the accompanying drawings in which:

FIGURE 1 is a diagrammatic view of an air-bag arrangement in a motor vehicle illustrating a problem that the present invention seeks to overcome,

FIGURE 2 is a diagrammatic view of an air-bag arrangement mounted in a motor vehicle in accordance with the invention with the air-bag in an initial phase of deployment,

FIGURE 3 is a view corresponding to Figure 2 showing a subsequent stage of deployment of the air-bag,

FIGURE 4 is a view corresponding to Figure 3 showing the occupant of a vehicle moving into contact with the air-bag,

FIGURE 5 shows a final phase of the use of the air-bag of Figures 2 to 4 with a seat occupant not wearing a seat belt,

FIGURE 6 shows a final phase of the use of an air-bag of Figures 2 to 4 with a seat occupant wearing a seat belt,

FIGURE 7 is a diagrammatic illustration showing how the top of the air-bag of Figures 2 to 5 is connected to the roof of the motor vehicle,

FIGURE 8 is a view corresponding to Figure 7 showing how the top part of the air-bag of Figures 2 to 5 becomes released,

FIGURE 9 is a view corresponding to Figure 5 showing a modified embodiment of the invention,

FIGURE 10 is a view corresponding to Figure 5 of another modified embodiment of the invention,

FIGURE 11 is a view corresponding to Figures 5 showing yet another modified embodiment of the invention,

FIGURE 12 is a diagrammatic view of an air-bag arrangement mounted in a motor vehicle in accordance with the invention with the air-bag in an initial retained position, and

FIGURE 13 is a view corresponding to Figure 12 showing the air-bag in the deployed condition.

Figure 1 illustrates, schematically, part of a vehicle 1. The vehicle has a roof, 2, a windscreen or windshield 3 and an associated A-Post 4. Incorporated within the vehicle is a dashboard 5. The front seat 6 of the vehicle is occupied by an occupant 7, and is illustrated as wearing a seat belt. Figure 1 illustrates an arrangement in which an air-bag 8 is provided which is initially mounted in a recess which is formed in the roof at a position extending across the top of the windshield 3. The air-bag 8 is illustrated in the inflated condition, showing the

situation that exists some milliseconds after the commencement of a frontal-impact accident.

It can be seen that as a consequence of the frontal impact, the air-bag 8 has been inflated and has been deployed to occupy a position in front of the occupant 7 of the vehicle. As a consequence of the deceleration of the vehicle, caused by the frontal impact, the occupant 7 of the seat 6 has moved forwardly relative to the seat. The seat belt has become tightened, thus retaining the pelvic region of the occupant of the seat. The main torso of the occupant of the seat has thus inclined forwardly.

The head of the occupant has been the first part of the occupant to make contact with the air-bag. Thus, the forwardly motion of the head of the occupant, relative to the vehicle, has been retarded, whilst the forward motion of the main torso of the occupant continued. Because the torso of the occupant was moving forwardly relative to the head of the occupant, the neck of the occupant became bent rearwardly, with the head of the occupant effectively being moved pivotally towards the rear, relative to the main torso of the occupant. Such a movement of the neck of the occupant is very undesirable, and may cause substantial injuries.

Figure 2 which illustrates an embodiment of the invention again shows, schematically, part of a vehicle 1, and illustrates the roof 2, windscreen or windshield 3, and an associated A-Post 4, dashboard 5 and front seat 6. The front seat is occupied by an occupant 7 who is not wearing a seat belt.

The vehicle 1 is provided with an air-bag arrangement in accordance with the invention. The arrangement includes an air-bag 8 which is initially retained, in a folded state in a recess 9 which extends transversely across at

least part of the top of the windscreen or windshield 3 within the roof 2 of the vehicle 1 at a position above and in front of the occupant 7 who is to be protected. The recess may be formed in the roof of the vehicle, or in a housing mounted in the roof. The air-bag is connected, by means of a flexible hose 10 to a gas generator 11 and an associated crash sensor 12. The gas generator 11 and crash sensor 12 are shown as being mounted behind the dashboard 5 of the vehicle, but may alternatively be positioned at another location within the vehicle. The flexible hose 10 extends from the gas generator 11 along the A-Post 4 to the air-bag 8. The hose 10 is releasably mounted in position on the A-Post 4.

As shown in Figure 2 the sensor 12 has sensed an accident and has activated the gas generator 11. Gas is being supplied by the gas generator 11, through the hose 10 to inflate the air-bag 8.

The air-bag 8 is partially inflated, and extends from the roof 2 of the vehicle to a point adjacent the upper part of the legs of the occupant. Thus the air-bag has initially occupied a position in which the entire volume of the bag is located in front of the occupant 7 before the occupant 7 has moved significantly forwardly relative to the vehicle.

The occupant of the vehicle could have been in a relatively forward position at the beginning of the accident. If the illustrated occupant is the driver, and if the occupant is short in stature, the seat of the occupant could be in a forward position. If the occupant were the front seat passenger, then the occupant could be leaning forwardly, for example to gain access to the glove box. Thus it is desirable that the air-bag 8, as it inflates, is as far forward as possible, to minimise the risk that the air-bag cannot be deployed in front of the occupant. Also the air-bag, during this phase of deployment should have a

minimum thickness, where thickness is understood to be the distance between the part 13 of the air-bag closest to the occupant 7 and the part 14 of the air-bag closest to the windscreen or windshield 3, as shown by the line T in Figure 2. It is to be understood that the thickness of the air-bag, as shown by the line T, is measured in a direction parallel to the axis of the vehicle.

Whilst it is possible to control the deployment characteristics of an air-bag by folding the air-bag in an appropriate manner, in the described embodiment of the invention the air-bag 8 is provided with a plurality of tear straps 15 each of which extends from the part 13 of the bag closest to the occupant 7, to the part 14 of the bag which is furthest from the occupant and closest to the windscreen or windshield 3. The tear straps hold the bag in the illustrated configuration during the initial phase of deployment. The tear straps are provided with regions of mechanical weakness (or are designed to have only a predetermined strength) and are adapted to tear or break when the pressure within the inflating air-bag 8 reaches a predetermined threshold. It is to be understood that instead of tear straps interconnecting the relevant parts 13,14 of the air-bag 8 tear threads could be used instead, these being threads adapted to snap when subjected to a predetermined force on inflation of the air-bag.

Figure 3 illustrates the phase of deployment of the air-bag 8 following the tearing of the tear straps 15. The thickness of the bag as measured in a direction parallel to the axis of the vehicle is now increasing, with the part 13 moving towards the occupant 7 and with the part 14 moving towards the windscreen or windshield 3. The occupant 7 is still in the initial position as during this initial phase of a typical accident the vehicle is decelerated relatively slowly as the crumple zone of the vehicle crumples.

Subsequently the vehicle decelerates more rapidly and, as shown in Figure 4, the occupant 7 moves forwardly relative to the seat 6 and the rest of the vehicle 1. The occupant 7 impacts with the bag 8. Because the occupant is not wearing a seat belt the torso 16 and the head 17 of the occupant engage the air-bag virtually simultaneously.

The torso 16 of the occupant may have a substantial mass and thus a substantial momentum relative to the vehicle 1. Thus the torso, even though it has impacted with the air-bag 8, will continue to move forwardly, as shown in Figure 5, thus compressing the air-bag 8. The head 17 of the occupant is engaging a part of the air-bag 8 which is close to the roof, and if the torso 16 moved forwardly while the head 17 was retained in the position shown in Figure 5 there would be a risk that the neck of the occupant 7 of the vehicle would be bent backwardly. This bending of the neck might lead to injuries that could permanently damage the occupant of the vehicle.

In the illustrated embodiment of the invention the upper part of the air-bag 8 is releasably connected to the recess within the roof 2 of the vehicle 1 in which the air-bag was initially stored or retained, as will be described below with reference to Figures 7 and 8. The arrangement is such that when the force, in a forward direction of the vehicle, applied to the air-bag by the occupant 7 exceeds a predetermined threshold the upper part of the air-bag 8 becomes disconnected from the recess within the roof 2 of the vehicle. The entire air-bag 8, which is still connected to the gas generator 11 by the flexible hose 10 is thus released from the recess within the roof 2 of the vehicle. The head 17 of the occupant can thus move forwardly, whilst being protected and retarded by the air-bag 8, with a greatly reduced risk that the neck of the occupant 7 will be bent back in an undesirable way.

There is no real risk of the air-bag leaving the desired position generally in front of the occupant 7 of the vehicle ,since when the air-bag is released from the roof of the vehicle the main part of the air-bag 8 is trapped between the torso 16 of the occupant 7 and the dashboard 5.

Thus the air-bag provides the desired protection for the occupant 7 of the vehicle whilst minimising the risk of the occupant suffering from undesired injuries as a consequence of backward bending of the neck.

Figure 6 shows the air-bag 8 of Figures 2 to 5 when used by an occupant 7 wearing a seat belt 18 at an advanced stage during an accident. The air-bag 8 is substantially completely inflated and the occupant 7 has moved forwardly relative to the seat 6 taking up all of the slack in the seat belt 18 and also slightly stretching the belt. It can be seen that the pelvic region of the occupant has been substantially retained by the belt, but the torso 16 is leaning forwardly as a consequence of the torso pivoting about the retained hips of the occupant 7 of the seat 6. The head 17 of the occupant has made contact with the air-bag, and this has applied a force to the air-bag sufficient to disconnect or release the top part of the air-bag from the recess in the roof. It is to be appreciated, however, that if the top part of the air-bag had not been disconnected from the recess, the head 17 of the occupant 7 would have been bent back, relative to the torso, (as shown in Figure 1) thus bending the neck of the occupant in an undesired manner.

Figure 7 shows the upper part of the air-bag 8 following deployment thereof. The air-bag 8 was initially retained in a recess 20 above the roof lining 21 behind a flap or door 22. Initially the flap or door 22 formed part of, or was mounted to be flush with or just behind, the roof lining so that the air-

bag arrangement was inconspicuous. On inflation of the air-bag 8 the door or flap 22 opened to permit the air-bag to descend to the position shown in Figure 2. The air-bag 8 is provided on each lateral side thereof (i.e. the side nearest the adjacent door, and the side adjacent the centre of the vehicle) with a loop 23. The loop passes through an aperture 24 formed in a release block 25 mounted within the recess 20. The block 25 may be made of a frangible material which is adapted to break when subjected to a predetermined force, but in the described embodiment of the invention one part of the block surrounding the aperture is provided with a line of mechanical weakness 26. A force applied to the release block by the loop 23 in excess of a predetermined threshold causes it to break at the line of mechanical weakness 26, thus permitting the loop 23 to escape in a generally forward direction from the aperture 24.

Referring now to Figure 8, when the occupant 7 applies a force to the air-bag 8 as a consequence of the forward movement of the head 17 or torso 16 of the occupant 7 the loop 23 will apply that force to the release block 25. If the force is in excess of a predetermined threshold, the block will break along the line 26 of mechanical weakness, thus releasing the top part of the air-bag from the roof of the vehicle. The only connection between the air-bag and the vehicle is then the flexible hose 10 that extends to the gas generator 11. The flexible hose 10 readily becomes disconnected from the A-Post 4 and the air-bag 8 is free to move forwardly and downwardly.

Figure 9 illustrates a modified embodiment of the invention. In this embodiment the vehicle 1 and the air-bag 8 are as described above but the air-bag 8 is provided with two side straps, only one of which, 30, is shown. Each side strap is secured to a respective lateral side part of the air-bag 8, and is so configured that when the air-bag 8 is inflated, as shown in Figure 9 the strap 30 extends to an anchor point 31 in the roof of the vehicle (or on the door frame

of the vehicle) located above and to the rear of the occupant 7 of the vehicle. Each strap 30 may be of triangular form, having a substantial width in the region of the strap adjacent the end thereof that is secured to the air-bag 8. The straps 30 assist in retaining the air-bag in the desired position in front of the occupant 7 of the vehicle. Also, if the occupant of the vehicle tends to move laterally for any reason (for example if the vehicle is subjected to an oblique impact) the straps will tend to guide the occupant sitting on the seat of the vehicle into contact with the inflated bag 8.

Figure 10 shows another embodiment of the invention in which the vehicle 1 and the air-bag 8 are very similar to that described with reference to Figures 1 to 5. In this embodiment the air-bag 8 is provided with two side straps which are equivalent to the side strap 30 described above. At least one of the side straps, preferably the side strap closest to the door adjacent to the occupant of the vehicle, but most conveniently both of the side straps, are of the form of the side strap 32.

The side strap 32 is generally of triangular form and extends from a mounting point 33 formed in the roof (or in the door frame) of the vehicle at a position above and behind the occupant 7 of the vehicle. The lower edge of the strap is in the form of a gas duct 34. The gas duct is connected to a gas generator 35 which is mounted in the roof of the vehicle together with a crash sensor 36 which is adapted to activate the gas generator should an accident occur. The gas generator and the sensor may, of course, be located at any convenient position within the vehicle.

The gas duct 34 may be connected to the air-bag 8 to supply the gas to the air-bag 8 necessary for the inflation thereof. The gas duct 8 is connected to a plurality of inflatable cells 37 that are located in a triangular zone of the strap

32 located above the gas duct 34. As the cells 37 inflate they adopt a cylindrical configuration, with the axes of the cells intersecting the line of the lower edge of the strap 32 as defined by the gas duct 34. As the cells 37 inflate, so the sidewalls of the cells adopt an outwardly bowed configuration, which effectively reduces the length of the strap 32, defined by the cells. Thus the strap 32 becomes tensioned between the air-bag 8 and the mounting point 33, as the strap inflates, tending to draw the air-bag towards the occupant 7 of the vehicle. However, the inflated cells 37 also form a protective cushion located between the head 17 of the occupant 7 and the adjacent window or door. This may minimise injury, especially in a side impact or roll over situation.

Figure 11 illustrates another modified embodiment of the invention which is similar to that shown in Figure 9. In this embodiment of the invention the triangular strap 30, as described in Figure 9 is connected to the roof 2 of the vehicle by means of an arrangement 40 which provides the dual effect of applying a tension to the strap 30, thus drawing the strap rearwardly, and consequently moving the inflated air-bag 8 towards the occupant 7 of the vehicle, and also providing a force-limiting effect which permits the air-bag 8 to move forwardly, against a retarding force provided by the force limiting arrangement.

In the embodiment illustrated in Figure 11, the end of the strap 30 is connected to a shaft 41 which is connected to a piston 42 contained within a cylinder 43. A gas generator 44 is provided adapted to inject gas into the cylinder 43 so as to move the piston towards the right in the orientation illustrated. As the piston moves towards the right, so a tension is applied to the strap 30, tending to draw the inflated air-bag 8 towards the occupant 7 of the vehicle.

When the occupant 7 moves forwardly relative to the seat, and impacts with the air-bag 8, a very substantial force may be transferred, from the air-bag 8 to the strap 30. This force will tend to move the piston 42 towards the left as illustrated. The piston 42 will be able to move towards the left, expelling gas from the cylinder 43, for example through a vent hole which surrounds the shaft 41. However, the movement of the piston in this direction is accompanied by a force limiting effect, and thus the forward movement of the piston and the strap 30 is effectively retarded by the described arrangement.

Whilst one particular apparatus has been illustrated which initially applied a tension to the strap 30, and which subsequently permits forwardly movement of the strap with a force limiting effect, alternative devices could be utilised.

Figure 12 illustrates a further embodiment of the invention. In this embodiment of the invention, the roof 2 of the vehicle defines a recess 50 which extends at least partly across the top of the windscreen or windshield 3. An air-bag 51 is provided which is initially retained, in a folded condition, within the recess 50. The air-bag is retained in position by means of a door 52 which initially closes the recess 50. The door 52 may form part of the roof lining of the vehicle, but may alternatively be flush with the roof lining of the vehicle or located immediately above the roof lining of the vehicle so that the air-bag arrangement is inconspicuous.

The air-bag 51 is connected by means of a flexible hose or conduit which extends along the A-Post 4 of the vehicle to a gas generator 11 which is associated with a crash sensor 12.

In the event that an accident should arise, the gas generator 11 is activated which initiates inflation of the air-bag 51. The door 52, which initially retains the air-bag 51 in the folded condition within the recess 50, consequently opens, and the air-bag begins to inflate. The air-bag, as can be seen in Figure 13, may be provided with internal tear straps 53, similar to the tear straps described above, in order to control the configuration of the air-bag during the initial stages of inflation thereof. However, the air-bag, which was retained within the recess 51 by the door 52, is no longer retained within the recess once the door 52 has opened. The air-bag thus falls to occupy a position, as illustrated in Figure 13, which is located directly in front of the occupant 7 of the motor vehicle.

CLAIMS:

1. An air-bag arrangement in a motor vehicle to protect an occupant of the vehicle in the event that an accident should occur, said arrangement incorporating an air-bag, the air-bag initially being retained in a folded condition within a recess at a position above and in front of the occupant to be protected, the air-bag being associated with a gas generator and a sensor, the sensor being adapted to sense an accident and activate the gas generator to inflate the air-bag, the air-bag, on inflation, being deployed in front of the occupant of the vehicle, the means retaining the air-bag in the recess being adapted to release the air-bag.

2. An air-bag arrangement according to Claim 1 wherein the air-bag is retained in position within the recess by means adapted to release the air-bag from the recess when a force in excess of a predetermined force is applied to the air-bag.

3. An arrangement according to Claim 2 wherein the upper part of the air-bag is secured to frangible means adapted to break to release the air-bag.

4. An arrangement according to Claim 2 wherein to retain the air-bag within the recess, the upper part of the air-bag is provided with a plurality of loops, each loop passing through an aperture formed in a release block, the release block being adapted to break to release the loop and thus to release the upper part of the air-bag.

5. An arrangement according to Claim 4 wherein the release block is provided with a line of mechanical weakness adjacent said aperture, the release block breaking at the line of mechanical weakness to release the loop.

6. An arrangement according to Claim 1 wherein the air-bag is initially retained in a folded condition within the recess by a door which initially closes the recess, the door being adapted to be opened on inflation of the air-bag, to release the air-bag during inflation thereof.

7. An arrangement according to any one of the preceding claims wherein the air-bag is provided with at least one strap extending from one lateral side of the bag to an anchor point located above and behind the occupant.

8. An arrangement according to claim 7 wherein two said straps are provided, each extending from a respective lateral side of the air-bag.

9. An arrangement according to claim 7 or 8 wherein the or each strap is of substantially triangular form, the end of the strap secured to the air-bag being wider than the end of the strap connected to the anchor point.

10. An arrangement according to any one of claims 7 to 9 wherein at least one strap incorporates at least one inflatable cell.

11. An arrangement according to claim 10 as dependent directly or indirectly on claim 8 wherein both straps are provided with at least one inflatable cell.

12. An arrangement according to claim 10 or 11 wherein the or each cell in the or each strap has a cylindrical form when inflated, the axis of the cell intersecting the line of the lower edge of the strap.

13. An arrangement according to claim 12 wherein there are a plurality of cells in the or each strap.

14. An arrangement according to any one of claims 11 to 13 wherein the or each strap incorporates a gas duct to supply gas to the or each cell, the gas duct supplying gas from the gas generator to the air-bag.

15. An arrangement according to any one of Claims 7 to 14 wherein the or each strap is connected to the anchor point by means of an arrangement which is adapted to apply a tension to the strap to draw the inflated air-bag towards the occupant of the vehicle.

16. An arrangement according to Claim 15 wherein the strap is connected to the anchor point by means which are adapted to provide a force limiting effect when subjected to a force via a strap.

17. An arrangement according to any one of the preceding Claims wherein the air-bag is constrained to be inflated in such a way that during the initial stages of inflation the air-bag is relatively thin (as measured in the direction of the axis of the vehicle) and is located in front of the occupant, and subsequently the thickness of the air-bag (as measured in the direction of the axis of the vehicle) increases.

18. An arrangement according to Claim 17 wherein the air-bag is provided with one or more breakable means extending from the part of the air-bag

closest to the occupant to the part of the air-bag furthest from the occupant, said breakable means being dimensioned to maintain the air-bag in a relatively thin condition (as measured in the direction of the axis of the vehicle) until a predetermined pressure is present within the air-bag.

19. An air-bag arrangement in a motor vehicle to protect an occupant of the vehicle in the event that an accident should occur, said arrangement *incorporating an air-bag, the air-bag initially being stored in a folded condition* at a position above and in front of the occupant to be protected, the air-bag being associated with a gas generator and a sensor, the sensor being adapted to sense an accident and activate the gas generator to inflate the air-bag, the air-bag, on inflation, being deployed in front of the occupant of the vehicle wherein the air-bag is constrained to be inflated in such a way that during the initial stages of inflation the air-bag is relatively thin (as measured in the direction of the axis of the vehicle) and is located in front of the occupant, and subsequently the thickness of the air-bag (as measured in the direction of the axis of the vehicle) increases.

20. An arrangement according to Claim 19 wherein the air-bag is provided with one or more tear straps or equivalent breakable means extending from the part of the air-bag closest to the occupant to the part of the air-bag furthest from the occupant, said tear straps or equivalent breakable means being dimensioned to maintain the air-bag in a relatively thin condition (as measured in the direction of the axis of the vehicle) until a predetermined pressure is present within the air-bag.

21. An arrangement according to Claim 19 or 20 wherein the air-bag is provided with at least one strap extending from one lateral side of the bag to an anchor point located above and behind the occupant.

22. An air-bag arrangement in a motor vehicle to protect an occupant of the vehicle in the event that an accident should occur, said arrangement incorporating an air-bag, the air-bag initially being stored in a folded condition at a position above and in front of the occupant to be protected, the air-bag being associated with a gas generator and a sensor, the sensor being adapted to sense an accident and activate the gas generator to inflate the air-bag, the air-bag, on inflation, being deployed in front of the occupant of the vehicle, wherein the air-bag is provided with at least one strap extending from one lateral side of the bag to an anchor point located above and behind the occupant.

23. An arrangement according to Claim 21 or 22 wherein two said straps are provided, each extending from a respective lateral side of the air-bag.

24. An arrangement according to Claim 21, 22 or 23 wherein the or each strap is of substantially triangular form, the end of the strap secured to the air-bag being wider than the end of the strap connected to the anchor point.

25. An arrangement according to any one of Claims 21 to 24 wherein at least one strap incorporates at least one inflatable cell.

26. An arrangement according to Claim 25 as dependent directly or indirectly on Claim 23 wherein both straps are provided with at least one inflatable cell.

27. An arrangement according to Claim 25 or 26 wherein the or each cell in the or each strap has a cylindrical form when inflated, the axis of the cell intersecting the line of the lower edge of the strap.

28. An arrangement according to Claim 27 wherein there are a plurality of cells in the or each strap.

29. An arrangement according to any one of Claims 26 to 28 wherein the or each strap incorporates a gas duct to supply gas to the or each cell, the gas duct supplying gas from the gas generator to the air-bag.

30. An arrangement according to any one of Claims 21 to 27 wherein the or each strap is connected to the anchor point by means of an arrangement which is adapted to apply a tension to the strap to draw the inflated air-bag towards the occupant of the vehicle.

31. An arrangement according to Claim 30 wherein the strap is connected to the anchor point by means which are adapted to provide a force limiting effect when subjected to a force via a strap.

32. An air-bag arrangement substantially as herein described with reference to and as shown in Figures 2 to 8 of the accompanying drawings.

33. An air-bag arrangement substantially as herein described with reference to, and as shown in, Figure 9 of the accompanying drawings.

34. An air-bag arrangement substantially as herein described with reference to, and as shown in, Figure 10 of the accompanying drawings.

35. An air-bag arrangement substantially as herein described with reference to and as shown in Figure 11 of the accompanying drawings.

36. An air-bag arrangement substantially as herein described with reference to and as shown in Figures 12 and 13 of the accompanying drawings.

37. Any novel feature or combination of features disclosed herein

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Application No: GB 9900619.9 **Examiner:** Peter Macey
Claims searched: 1 - 36 **Date of search:** 15 June 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): B7B (BSBCC, BSBCM, BSBCR)

Int Cl (Ed.6): B60R 21/16, 21/20

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 1335324	(Allied Chemical) see especially figure 1	1 - 3
X	GB 953312	(Kent) see especially figures 1 and 3	1, 2
X	US 5772238	(Automotive Technologies) see especially figures 1, 6 and 7	1, 2, 6
X	US 5458367	(Lockheed Idaho) see especially figure 1	1, 2, 6
X	US 5366241	(Kithil) see especially figure 2	1 - 3
X	US 4536008	(Brown) see especially figure 2	1, 2, 6, 17, 19

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.